CHROM. 4592

M. S. TSWETT—HIS LIFE

K. SAKODYNSKY
Karpov's Institute of Physical Chemistry, Moscow (U.S.S.R.)

It is not infrequent in the history of science that, for some reason or other, discoveries remain in prolonged obscurity and only gain recognition and extensive application after they have appeared much later in papers by other scientists. Such was the fate of a discovery made in the early twentieth century by Mikhail Semenovich Tswett, a young Russian botanist and exceptionally modest and painstaking scientist. His discovery has transformed modern analytical chemistry and resulted in basically new concepts of control and automation in chemical processes.

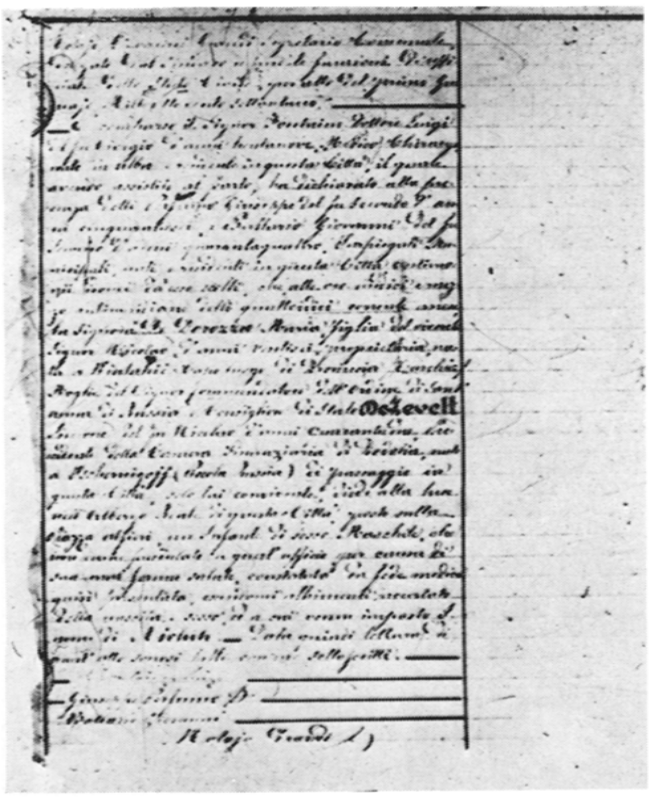
Little is known about Mikhail Semenovich Tswett himself[1,2]. He was born on May 14, 1872* in the little town of Asti in Northern Italy. His father, Semen Nikolaye-

Fig. 1. Mikhail Semenovich Tswett.

* Sometimes his birth is erroneously given as May 19. This mistake is traced down to a form once filled in by Tswett himself.

Fig. 2. Hotel "Reale", where Tswett was born on May 14, 1872.

vich Tswett, held a high position in the civil service, and his mother was an Italian, Maria Dorozza by name. Tswett belonged to the Orthodox Church, and was educated in Switzerland, where he first went to Galliard's College in Lausanne and then to the St. Anthony Gymnasium in Geneva. In 1891 he entered the Faculty of Natural Sciences



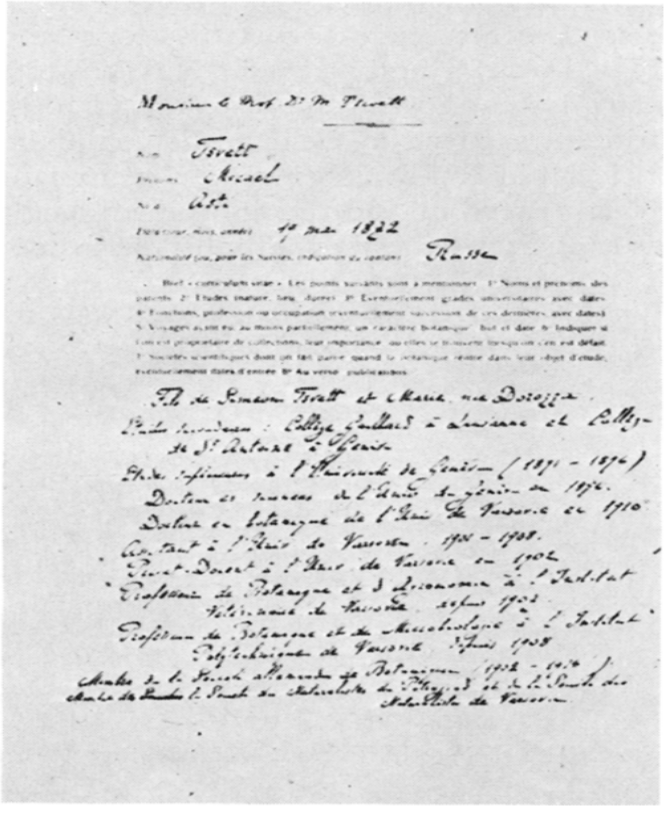


Fig. 3. The birth certificate of Tswett.

Fig. 4. A *curriculum vitae* form filled in by Tswett.

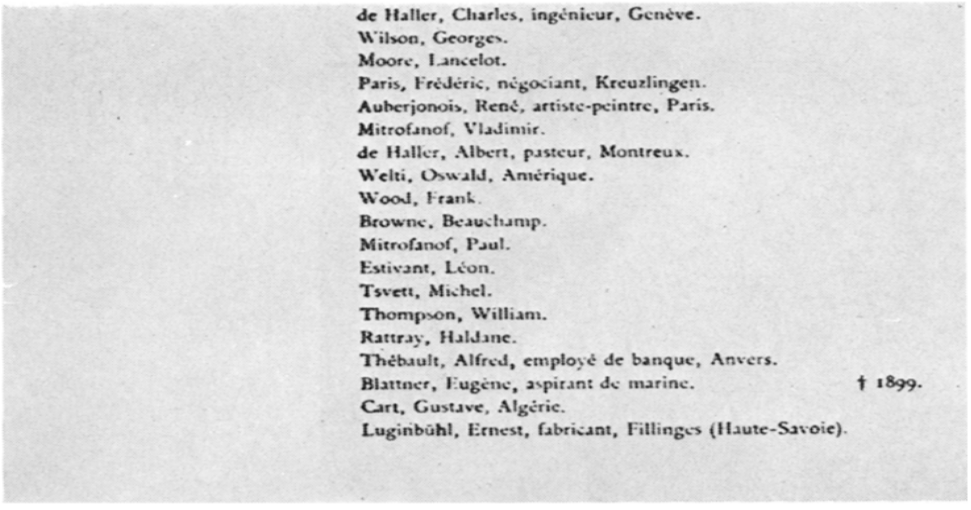

de Haller, Charles, ingénieur, Genève.
Wilson, Georges.
Moore, Lancelot.
Paris, Frédéric, négociant, Kreuzlingen.
Auberjonois, René, artiste-peintre, Paris.
Mitrofanof, Vladimir.
de Haller, Albert, pasteur, Montreux.
Welti, Oswald, Amérique.
Wood, Frank.
Browne, Beauchamp.
Mitrofanof, Paul.
Estivant, Léon.
Tsvett, Michel.
Thompson, William.
Rattray, Haldane.
Thébault, Alfred, employé de banque, Anvers.
Blattner, Eugène, aspirant de marine. † 1899.
Cart, Gustave, Algérie.
Luginbühl, Ernest, fabricant, Fillinges (Haute-Savoie).

Fig. 5. The list of students in Galliard's College in Lausanne.

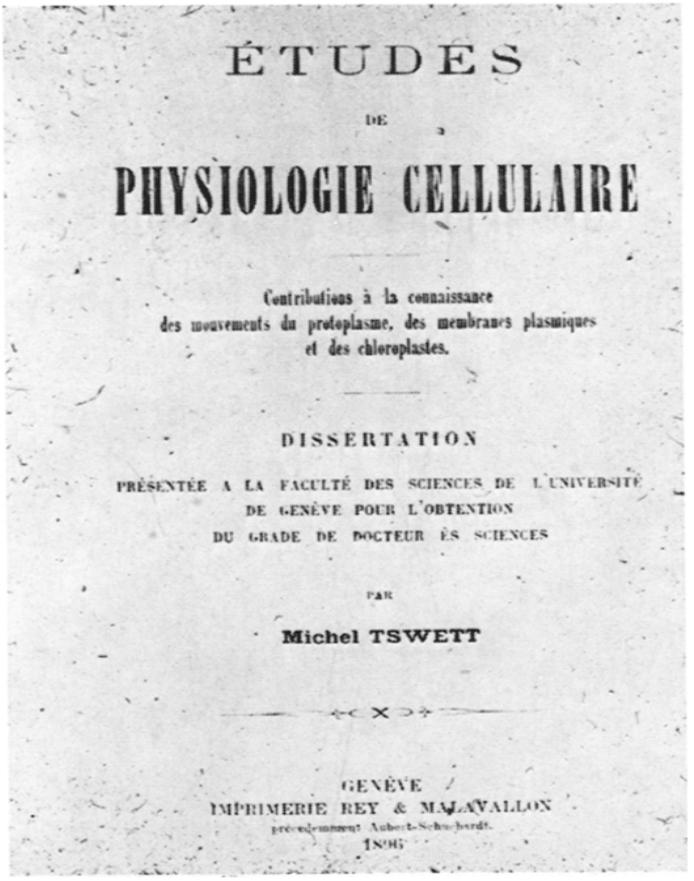
at Geneva University; his interests at that time included botany, chemistry and physics. Much of his time there was taken up by his first research work at the general botanical laboratory, for which he was awarded a University prize. It was in this laboratory that Tswett worked for his Doctorate thesis in cell physiology, which was successfully presented in 1896. In 1896 he migrated to Russia, where he first stayed in Simferopol for half a year, and then moved to Petersburg to work in Professor Lesgaft's private institute for women.

Tswett's first years in Russia were not easy. His doctorate degree was not recognised and was of no use, so he had to work again for a degree. In his letters to Briquet, a friend in Geneva, he complained of a difficult life and was frank in his criticism of Russian society. He even planned to leave Russia. But by and by things straightened out and though some difficulties still remained, he made friends among his countrymen, and eventually settled down to work with enthusiasm*.


Le Collège Galliard sur la place de Chauderon à Lausanne.

Fig. 6. The college building, Galliard (now destroyed).

* It might be of interest to cite here CHARLES BAEHNI, who contributed considerably to the search of all available materials bearing on Tswett's life: "Like most Slavs, he possessed a certain charm which created a friendly atmosphere around him... Although he denied this fact in his letters, he was fundamentally a Russian and did not hesitate to return to his country".


ÉTUDES

DE

PHYSIOLOGIE CELLULAIRE

Contributions à la connaissance
des mouvements du protoplasme, des membranes plasmiques
et des chloroplastes.

DISSERTATION

PRÉSENTÉE A LA FACULTÉ DES SCIENCES DE L'UNIVERSITÉ
DE GENÈVE POUR L'OBTENTION
DU GRADE DE DOCTEUR ÈS SCIENCES

PAR

Michel TSWETT

GENÈVE
IMPRIMERIE REY & MALAVALLON
1896

Fig. 7. The dissertation of Tswett presented at the University of Geneva.

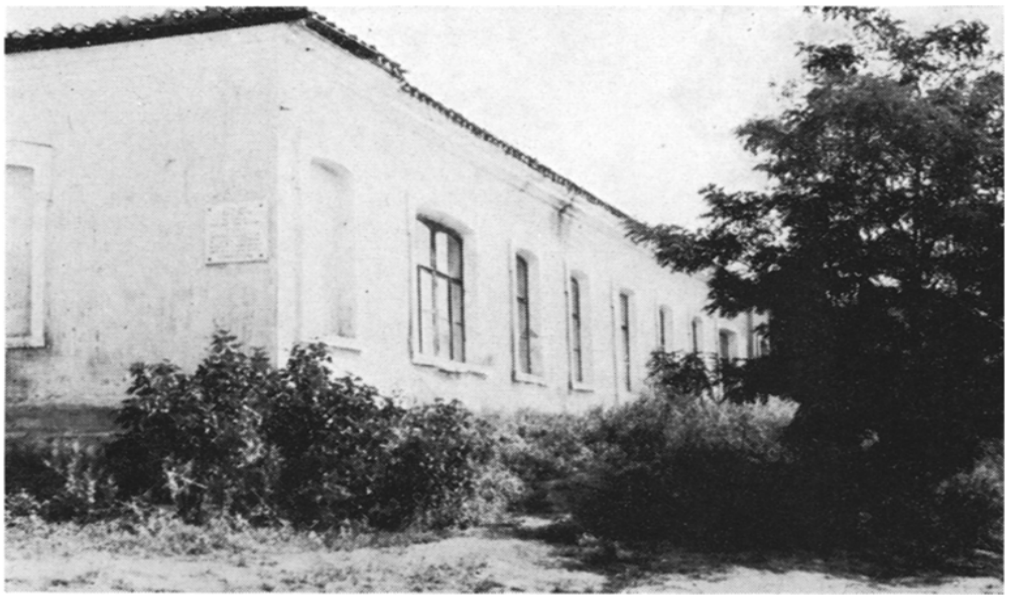


Fig. 8. The house of Steven in Simferopol.

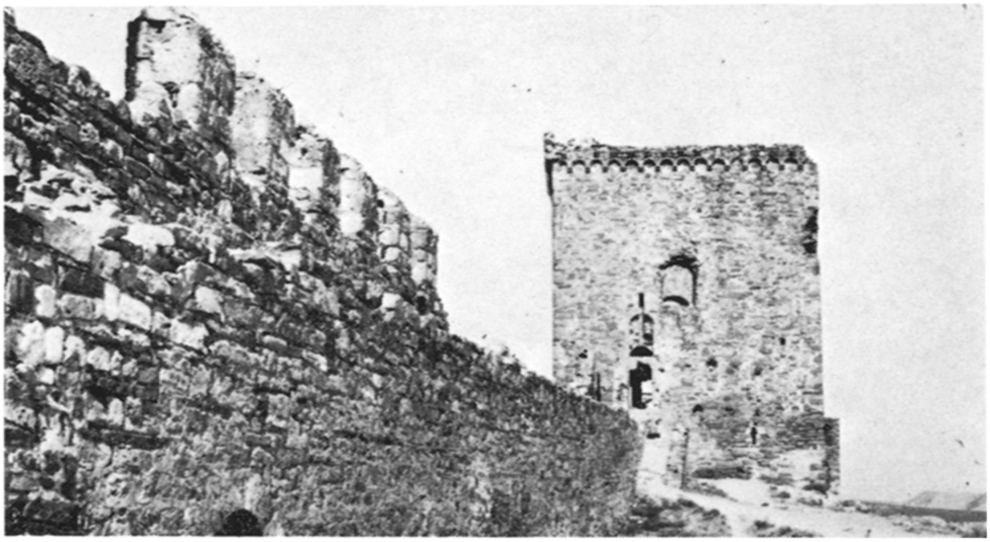
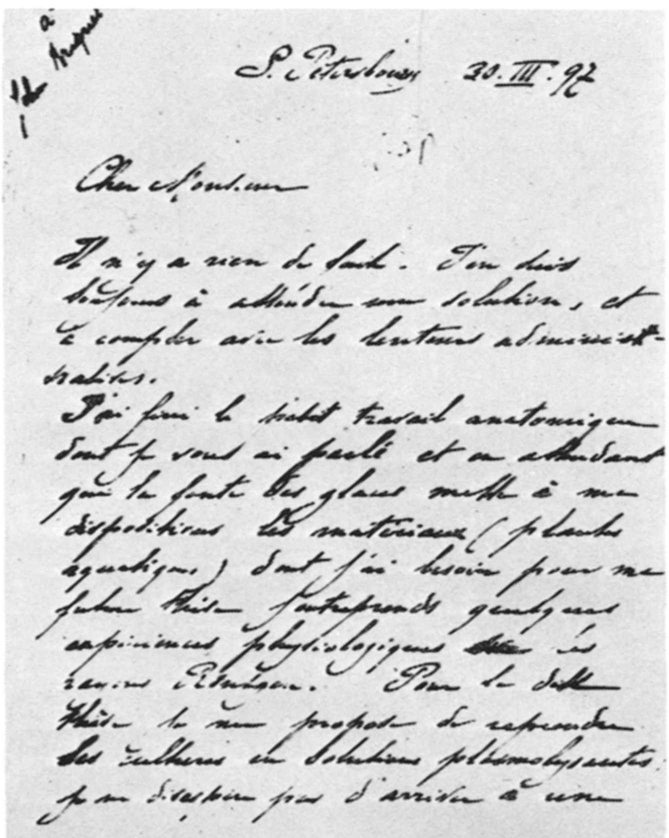


Fig. 9. The old castle in Sudak built by Genuese where Tswett was during his vacation in 1898.

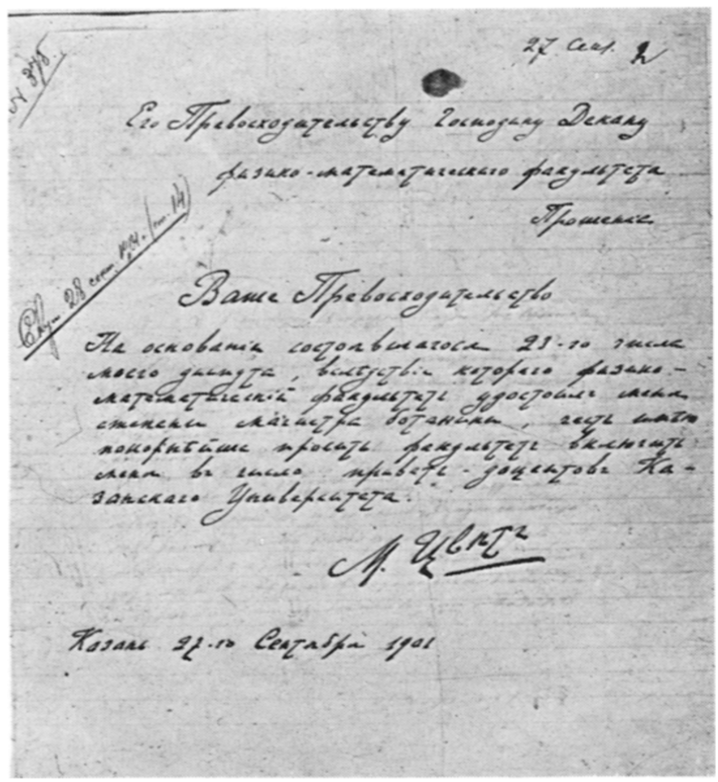


S. Pétersbourg 30.III.97

Cher Monsieur

Il n'y a rien de fait. J'en suis toujours à attendre une solution, et à compter avec les lenteurs administratives.

J'ai fini le petit travail anatomique dont je vous ai parlé et en attendant que la fonte des glaces mette à ma disposition les matériaux (plantes aquatiques) dont j'ai besoin pour ma future thèse j'entreprends quelques expériences physiologiques sur les [illegible]. Pour la dite thèse je me propose de reprendre les cultures en solutions plasmolysantes pour décider pas d'arriver à une



№ 378

27 Сент. 2

Его Превосходительству Господину Декану физико-математическаго факультета

Прошеніе

Ваше Превосходительство

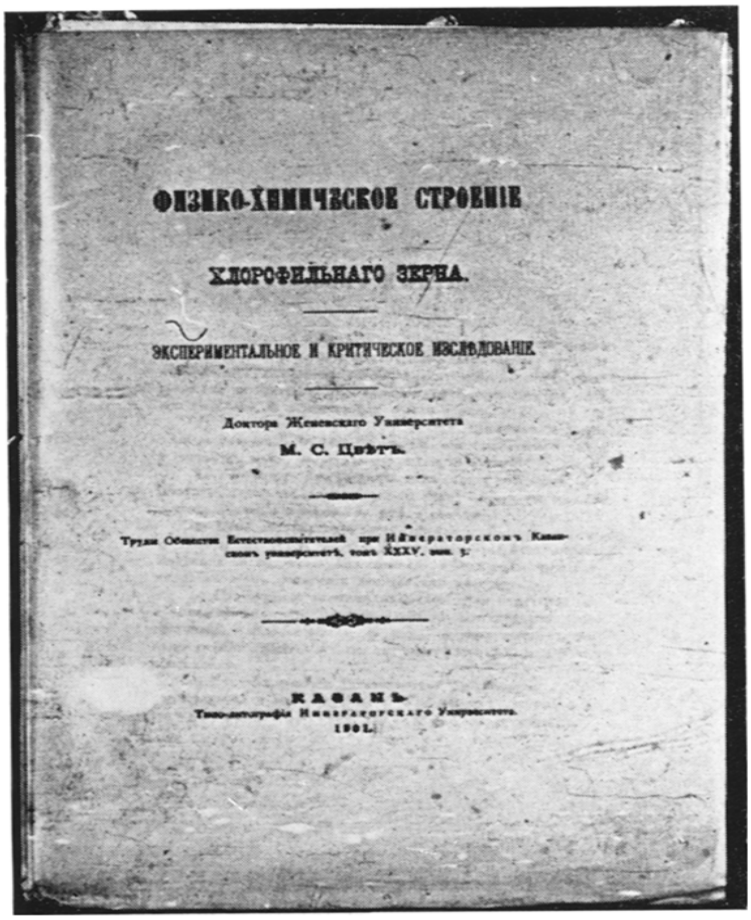
На основаніи состоявшагося 23-го числа моего диспута, вслѣдствіи котораго физико-математическій факультетъ удостоилъ меня степени магистра ботаники, честь имѣю покорнѣйше просить факультетъ включить меня въ число приватъ-доцентовъ Казанскаго Университета.

М. Цвѣтъ

Казань 27-го Сентября 1901

Fig. 10. One of the letters written by Tswett to his friend Briquet.

Fig. 11. A letter written by M. Tswett to the dean of the University of Kazan.


ФИЗИКО-ХИМИЧЕСКОЕ СТРОЕНІЕ

ХЛОРОФИЛЬНАГО ЗЕРНА.

ЭКСПЕРИМЕНТАЛЬНОЕ И КРИТИЧЕСКОЕ ИССЛѢДОВАНІЕ.

Доктора Женевскаго Университета

М. С. Цвѣтъ.

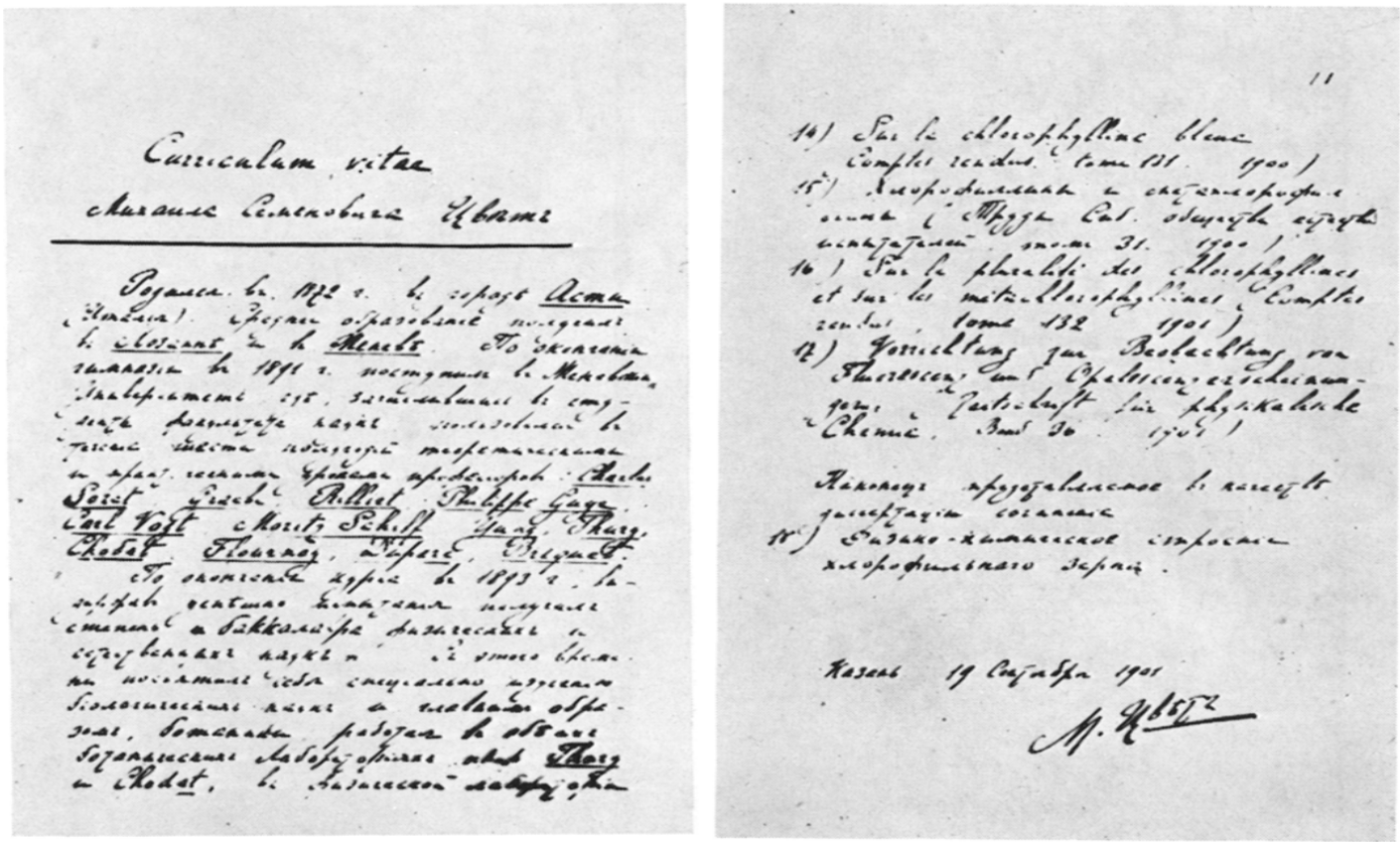
КАЗАНЬ

1901.

Fig. 12. The title of the Russian Master's dissertation.

In Petersburg, Tswett made the acquaintance with and had the friendship of many a distinguished Russian botanist, particularly Academician A. S. Famintsin, in whose laboratory he worked without having a position on the staff. In 1900, on the recommendation of several prominent scientists, Tswett was given a membership to the Petersburg Society of Natural Scientists.

Fg. 13. The main building of Kazan University.



Curriculum vitae

11

Fig. 14 and Fig. 15. The *curriculum vitae* of Tswett.

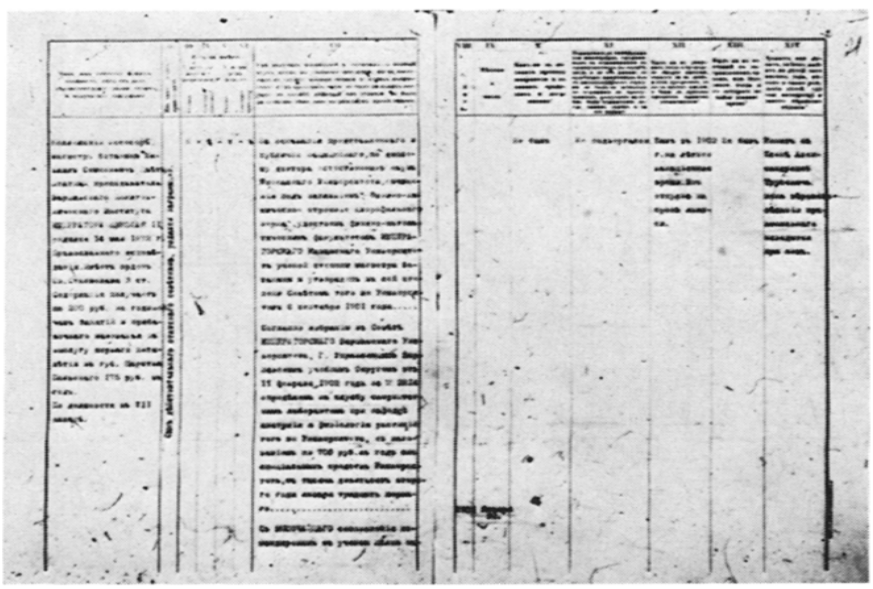


Fig. 16. The service form of Tswett as an assistant of Warsaw Polytechnical Institute.

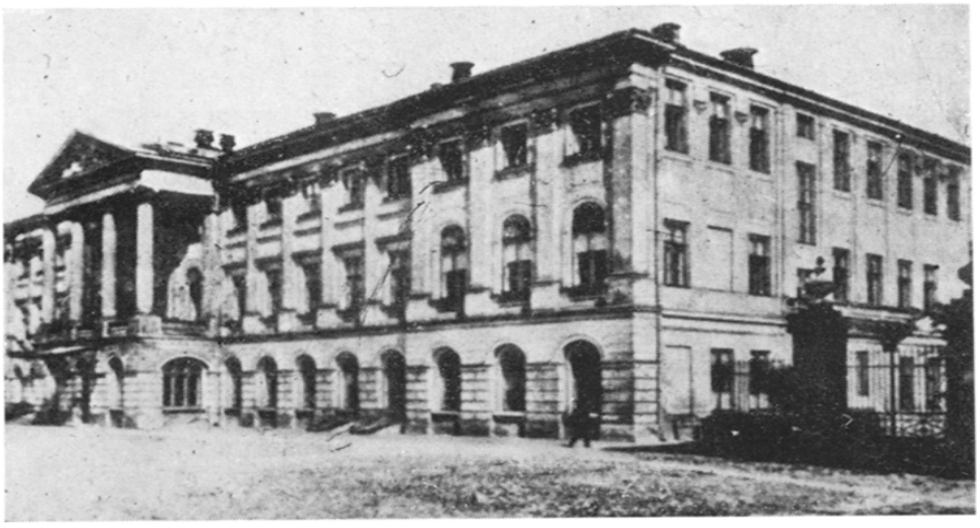


Fig. 17. The University building, Warsaw.

By the year 1901 Tswett had prepared his thesis for his Russian Master's degree entitled "Physical and chemical study of chlorophyll. Experiments and analysis". After the Master's qualifying examination on September 21, Tswett presented his dissertation at Kazan University. In addition to a successful presentation, Tswett proved to be a brilliant lecturer with a talent and alacrity for vivid and simple interpretation of the most complex phenomena.

In January 1902, Tswett moved to Warsaw where he first took the insignificant position of a supernumerary laboratory assistant, then that of an instructor at the Department of Plant Anatomy and Physiology, but before the end of 1902 he was promoted to an assistant professorship and was qualified to lecture. Tswett spent fourteen years in Warsaw. His discovery of chromatography belongs to this Warsaw period, though the fundamentals of the method had been outlined in his dissertation for his Russian Master's degree. In 1907, Tswett became a Reader in botany and agriculture at the Warsaw Veterinary Institute, and in 1908 was put on the staff of the Warsaw Polytechnical Institute as a Reader in botany and microbiology at the Chemistry and Mining Department. Whilst in Warsaw Tswett met Helena Alexandrovna Trusevich, and in late 1908 they married.

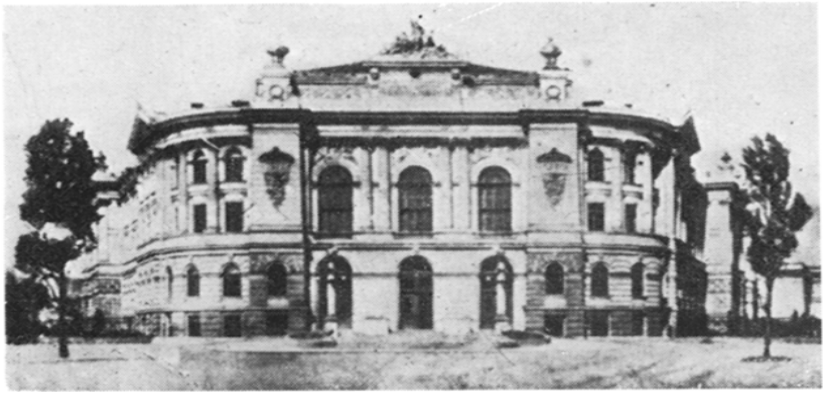
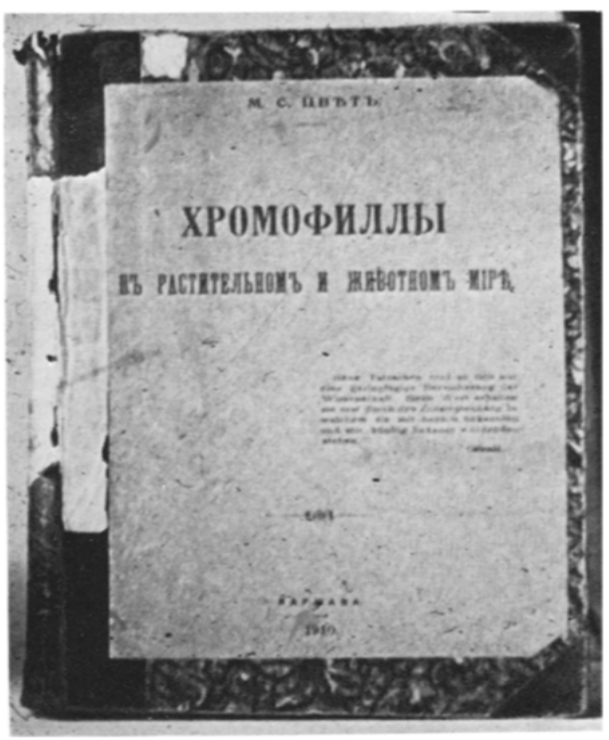


Fig. 18. The Polytechnical Institute building in Warsaw.

Fig. 19. The house on Mokotovskaya Street in Warsaw.

This initial period in Warsaw was a fruitful one for the young research worker As early as in Petersburg, Tswett had given particular attention to the central problem of his life, the mystery of green chlorophyll. He persisted in searching for a physical method to separate even the most complex mixtures, and he was convinced that chlorophyll was not a simple substance.



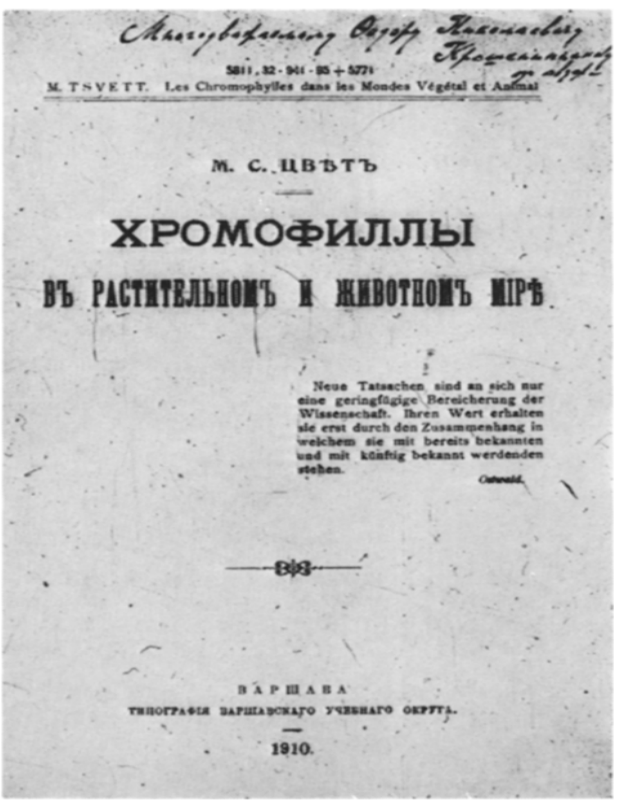


Fig. 20. Title of the book by Tswett presented as his Doctor's thesis in 1910.
Fig. 21. The first page of this book with some words written by Tswett (see Fig. 20).

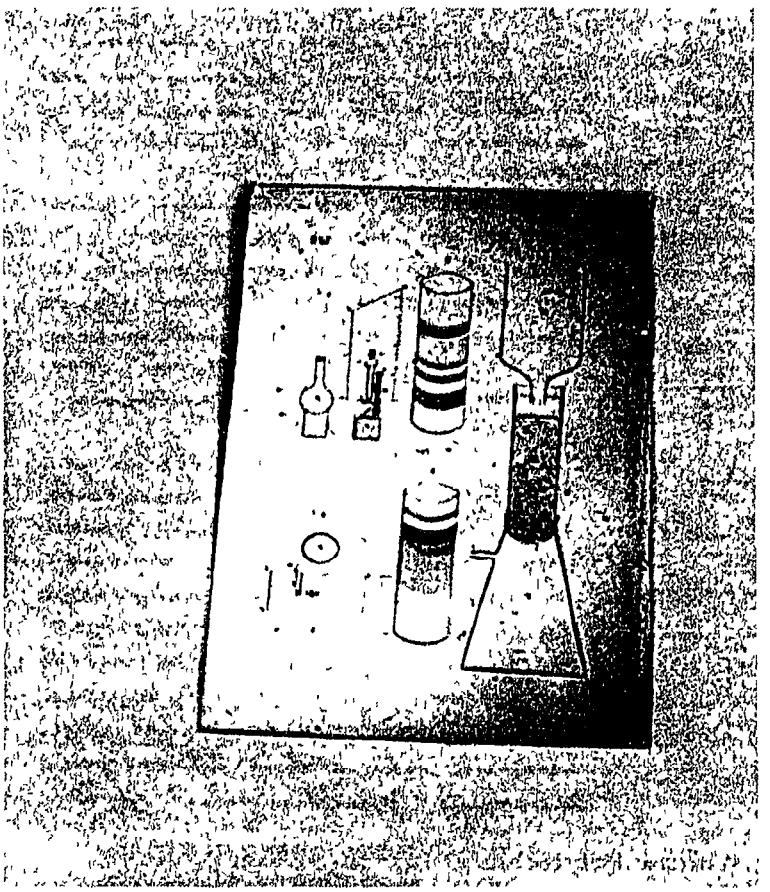
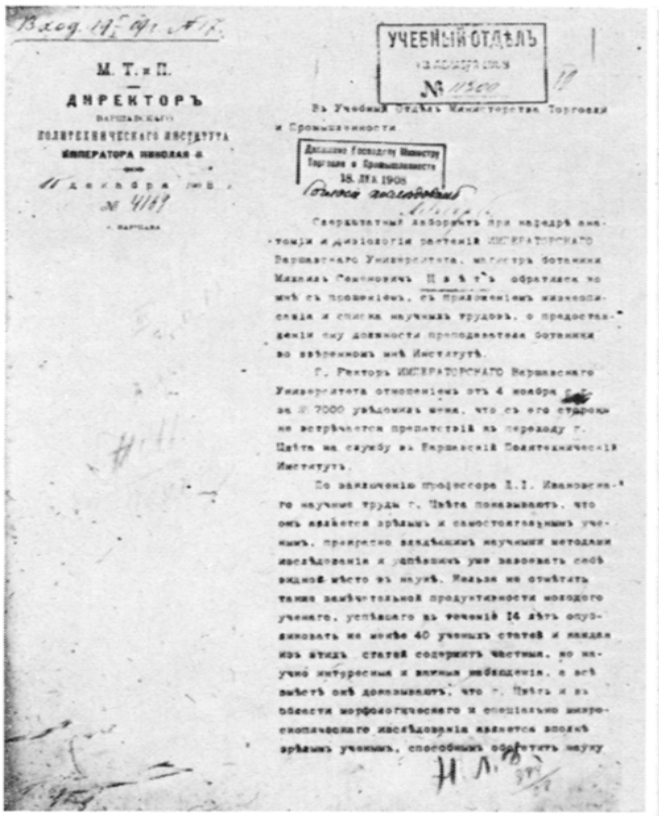


Fig. 22. The first chromatograph and the first chromatogram.

Numerous experiments, and days and nights of questing were spent until the method was found. It was quite simple. Its simplicity was its main advantage, which unfortunately was not appreciated by many of his contemporaries. The method is so simple that one cannot help being surprised that it had not been found before Tswett's time though many had almost discovered it.

Tswett's experiments whereby complex substances could be separated in a chalk-filled tube not only inaugurated an attack on the mystery of the green leaf, but also laid the foundation for a new method of separation—chromatography. Tswett wrote: "Thus the prospects open up for the construction of a new method of physical separation of the various substances present in organic liquids. The method is based on the ability of soluble substances to mix with various solid mineral and organic substances to form physical adsorption compounds". In addition, Tswett framed the idea of his discovery in the following poetic words: "Similarly to light beams in the spectrum" the different components of a complex pigment are regularly distributed one after another in the adsorption column and thus lend themselves to qualitative and quantitative analysis. I have called such a multi-coloured preparation a CHROMATOGRAM, and the respective method of analysis a CHROMATOGRAPHIC METHOD*.

* Gr. CHROMA—colour, GRAPHEIN—writing. In this connection H. PURNELL[4], an Oxford professor, remarked: "It is pleasing to think that Tswett, whose name in Russian means literally COLOUR or TINT, used this chance to demonstrate his sense of humour".



УЧЕБНЫЙ ОТДѢЛЪ

№ 11200

М. Т. и П.

ДИРЕКТОРЪ

ПОЛИТЕХНИЧЕСКАГО ИНСТИТУТА

ИМПЕРАТОРА НИКОЛАЯ II

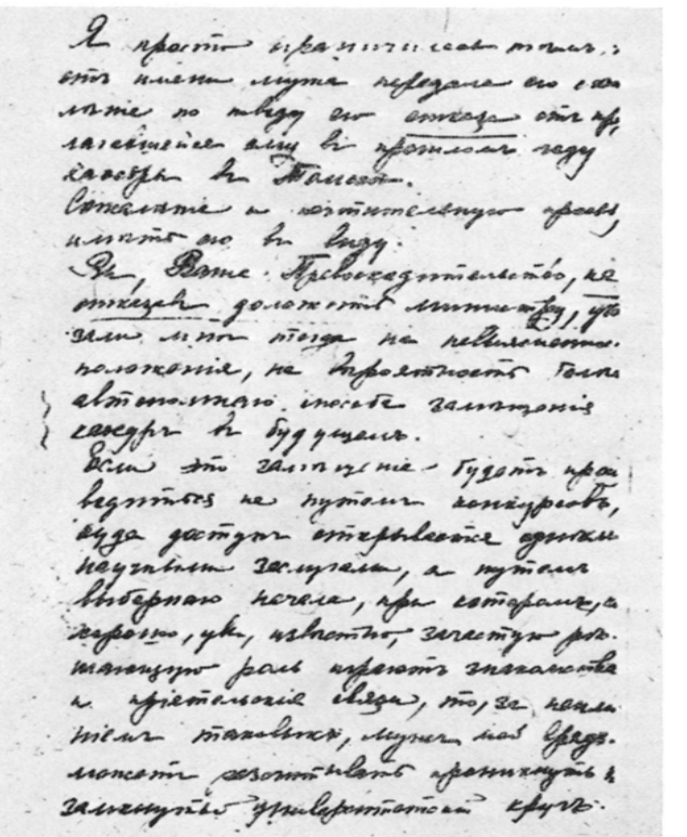


Fig. 23. A letter from the director of the Warsaw Polytechnical Institute about Tswett.

Fig. 24. Part of a letter by Elena Tswett.

It may seem strange that Tswett initially restricted his method to coloured substances only. However, in his very early work he made it absolutely clear that the adsorption analysis utilized primarily for pigments could also be used for colourless, in other words invisibly "coloured" substances.

Tswett's first work on adsorption chromatographic analysis was published in Russian in 1903 in the Proceedings of the Warsaw Society of Natural Scientists, unlike most of his papers which were written in German or French. On November 29, 1910 he presented his Doctorate dissertation in botany "Chromatophylls in plants and animals". This work was later awarded the M. A. Akhmatov Grand Prize of the Russian Academy of Science and published as a monograph. Even at this stage a systematic description of the chromatographic method is given and the results of research into the adsorption characteristics of over one hundred and ten substances and data on a great number of solvents are cited. He also describes research techniques and their facility. The information presented in the book is remarkable for its coverage, exhaustiveness and minuteness of detail.

Going back to the method itself, at first Tswett's discovery caught the public interest. It was discussed in special journals and in the press. Reputable publications in biochemistry which saw light in 1912 carried large articles on the chromatographic method. It was acclaimed everywhere. As an example, it will just suffice to quote the reference about Tswett dated 1908 when he was leaving Warsaw University for the

Warsaw Polytechnical Institute. "Scientific works by Mr. Tswett show him as a mature and competent worker in perfect command of research techniques and with quite a reputation in the scientific community. Also worth mentioning is the prolific number of papers this young scientist has published in the course of the past fourteen years—at least forty. Each of these contains interesting and important observations qualifying him as a mature scientist in the field of morphological and special microscopic analysis, able to make valuable contributions to science".

More than once during his Warsaw period Tswett was sent abroad to study the teaching standards in higher educational institutions, specifically in the Botanical Institutes of Berlin and Kiel. He also attended scientific congresses in Moscow and Petersburg, where he presented his papers. He became a member of the Warsaw Society of Natural Scientists and of the German Botanical Society.

Yet, in spite of all this, Tswett's method did not become popular in his lifetime. Probably, an unfavourable reference to it by a then prominent scientist, Willstätter, is responsible for this. According to Zechmeister, Tswett's work aroused a "tacit distrust" in many a colleague. In later years Tswett's discovery brought him no recognition and, even worse, discredited him as a scientist*.

At the same time Tswett grew more and more uninterested in teaching freshmen at the Polytechnical Institute. He yearned for more new experiments to develop his ideas and prove their validity, but was compelled to teach botany and microbiology to first-year students for whom it was almost optional. He attempted to find a position

Fig. 25. One of the last photos of Tswett.

* One of the few scientists still alive who knew Tswett, S. I. Sokolov, Professor of the Moscow Chemical Engineering Institute, refers to the atmosphere of suspicion which clouded Tswett's report in Warsaw. He recalls Tswett's painful reaction to the groundless attacks on his well-proven results.

in the Botany department of the Samara or Novoalekseyevsk Institutes. He applied to the Ministry of Education and the Ministry of Industry and Commerce. People who knew him well appreciated him highly, but burocratic officials preferred references from "influential" persons. Thus, G. Levitsky, Chief Trustee of educational establishments of the Warsaw District wrote in 1903: "Doctor Tswett has been teaching botany, lecturing and tutoring at the Chemistry Department of the Polytecnic Institute for several years. As an instructor he proved himself to his credit. His teaching of botany has been on a highly scientific footing and is effected in a perfect manner. He has a way of dealing with students and owing to this there has never been even the slightest conflict. His morals are very high; he has an unbiassed and ardent devotion to duty, is modest notwithstanding his prominence in science, industrious, kind and sympathetic, and has lofty and pure ideals".

Fig. 26. The building of Masing's Gymnasium in Moscow where Tswett worked from 1915–1916.

On the other hand, the reference by V. V. Zalessky, an expert of the Tsarist Ministry of Education, reads: "By the standards of his scientific works Mr. Tswett is considerably inferior to all the other claimants to the Chair. Mr. Tswett lacks competence in the techniques of the experimental sciences, which require rigorous research methods, and precision and caution in interpreting the results; his attitude towards facts is not sufficiently critical, thus hasty conclusions are drawn and unsubstantiated ideas may be put forward". It was thus concluded that Tswett would not fit into the position for which he had applied.

How popular became the point of view expressed by Zalessky and other "competent persons" can be seen from a letter by Elena Tswett to the Deputy Minister of Education, which was found in the archives. Here are several quotations from it: "If positions at the departments are not to be obtained on a competitive basis, which gives priority to scientific standards alone, but just by selection, which, alas, more often than not depends on connections, then my husband, who has none, will have only a very slim chance of penetrating the exclusive University community. The only hope which remains in this case is an extraordinary appointment by the Minister himself". And

Fig. 27. The house where Tswett lived in Moscow (Pokrovka 45).

further: "Time is not wholly unimportant for my husband. If he is to be saved from hard conditions and onerous work, which are virtually ruining him, for he has a poor health, it must be done at once." "All his energy is consumed in teaching, which brings no moral satisfaction. Scientific ideas are a dead weight, for there is nobody who cares enough to inherit and take an interest in them. All his personal research is cut down to a minimum. And the best years are being wasted."

Fig. 28. The University of Tartu.

Fig. 29. Halutin street in Voronezh.

His wife's letter gives a very accurate picture of the atmosphere in which Tswett lived before the Revolution, and the spirit of this outstanding scientist could not exist in this atmosphere.

When the German Army approached Warsaw in 1915 Tswett moved first to Moscow and then, in late summer of 1916, to Nizhny Novgorod. All his archives and books were left in Warsaw, where they were lost.

Finally, in 1917, Tswett received the long-hoped-for position as Director of the Botanical Gardens in Tartu (then Yurief). He was already ill at that time. When Tartu was occupied by the Germans in February 1918, Tswett was ill but one month later he left Tartu for Voronezh notwithstanding his German friends' efforts to persuade him to stay, to become one of the first professors of the Voronezh University. In Tartu and in Voronezh his health deteriorated. He gave his lectures sitting at a desk. Though

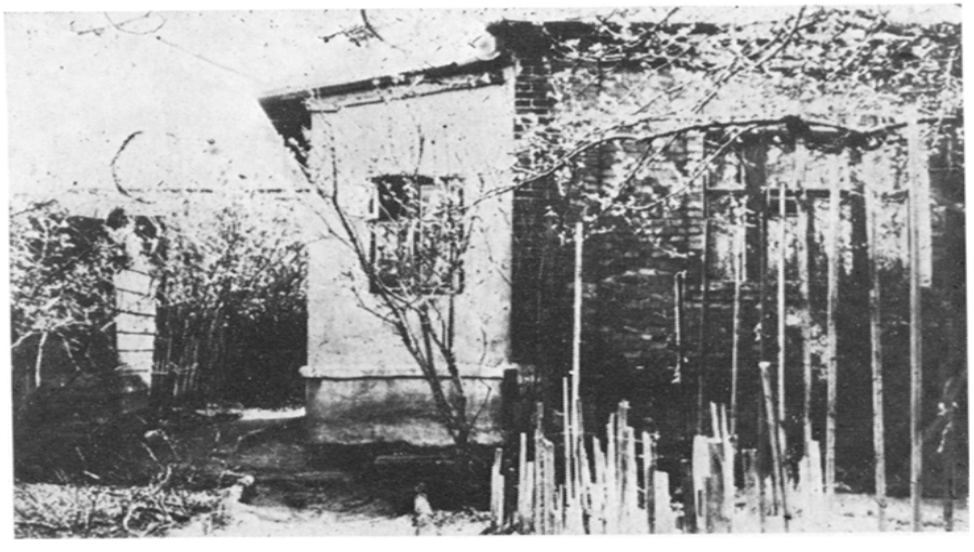


Fig. 30. The small house where Tswett lived in Voronezh in his last year.

his intellect was as bright as ever and his phrasing strictly consistent, it was felt by everybody that lecturing put a great strain on him. According to the University medical staff, Tswett was suffering from heart disease. He lived his last year in a small room of Professor Verevkin's house in Khalyutinskaya Street (now Baturinskaya), 20. He died on June 26, 1919 in a hospital and was buried in the cemetery in the vicinity of the Alexey monastery. During the Second World War the cemetery was destroyed and Tswett's grave cannot be located now. The memorial plate put up in June 1969 in Baturinskaya 20 reads: "Here lived the prominent Russian scientist Mikhail Semenovich Tswett, 1872–1919".

REFERENCES

1 M. S. TSWETT, *Chromatographic Adsorption Analysis (Selected works)* (in Russian), USSR Academy of Sciences, 1946
2 G. HESSE AND H. WEIL, *Michael Tswett's first paper on chromatography*, M Woelm, 1954.
3 *Archive of the Botanical Garden of Geneva University.*
4 H. PURNELL, *Gas Chromatography*, John Wiley, New York, 1968, p. 1.